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INDO-PACIFIC FISHERY COMMISSION

Report of the fifth session of

THE INDO-PACIFIC FISHERY COMMISSION WORKING PARTY OF EXPERTS ON INLAND FISHERIES

Bogor, Indonesia, 24-29 June 1991

and

Report of the workshop on

TILAPIA IN CAPTURE AND CULTURE-ENHANCED FISHERIES IN THE INDO-PACIFIC FISHERY COMMISSION COUNTRIES

Bogor, Indonesia, 27-29 June 1991

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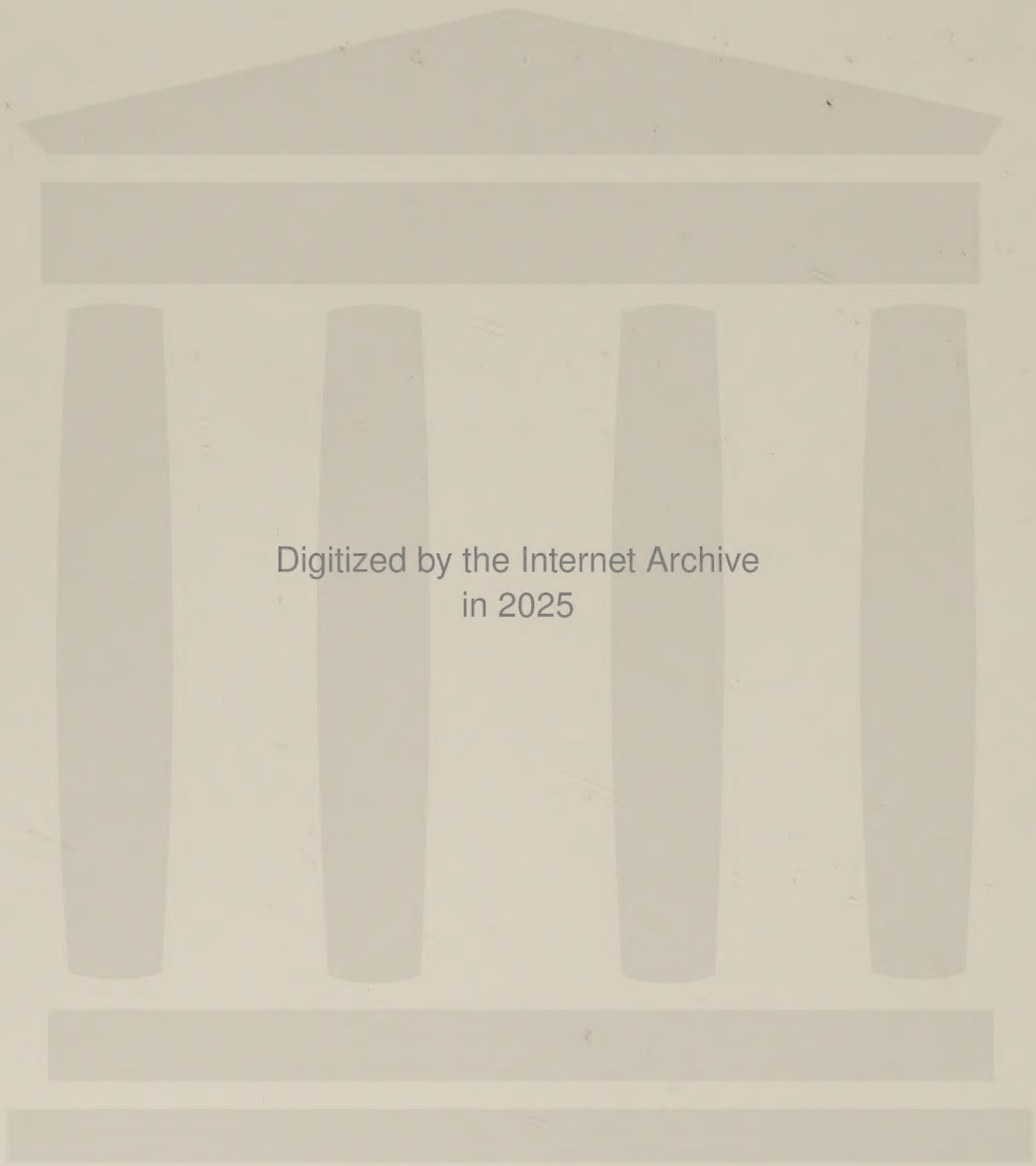

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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PREPARATION OF THIS DOCUMENT

This document is the final version of the report adopted on 29 June 1991 by the participants at the Fifth Session of the Indo-Pacific Fishery Commission Working Party of Experts on Inland Fisheries, which met in Bogor, Indonesia, 24-29 June 1991. It also includes the Report of the Workshop on Tilapia in Capture and Culture-Enhanced Fisheries in the IPFC Countries, held in Bogor, Indonesia, 27-29 June 1991.

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ABSTRACT

This document presents a review of the activities in inland fisheries during the intersessional period 1988-1991 and the results of discussions during the Fifth Session of the Indo-Pacific Fishery Commission Working Party of Experts on Inland Fisheries, which met in Bogor, Indonesia, 24-29 June 1991. It also includes the Report of a Workshop on Tilapia in Capture and Culture-Enhanced Fisheries in the IPFC countries, which met during the Fifth Session of the Working Party. Edited papers presented during the Workshop and country status reports are issued as a supplement to this report.

Distribution:

Members of the Indo-Pacific Fishery Commission
Members of the Working Parties
Other interested international organizations
FAO Fisheries Department
FAO Regional Fisheries Officers

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REPORT OF THE FIFTH SESSION OF THE IPFC WORKING PARTY OF EXPERTS ON INLAND FISHERIES BOGOR, INDONESIA, 24-29 JUNE 1991

A. OPENING OF THE GENERAL SESSION OF THE WORKING PARTY

The Fifth Session of the Working Party was opened by Dr. Fatuchri Sukadi, Director of the Research Institute of Freshwater Fisheries. This was followed by speeches of Mr. Danilo Vujicic, the FAO Representative in Indonesia, Dr. Fuad Cholik, Director of the Central Research Institute for Fisheries, and Dr. T. Petr, Technical Secretary of the Working Party. The first two days of the Meeting were devoted to a review and discussion of the implementation of the Programme since the Fourth Session of the Working Party. Dr. D. Coates, Chief Technical Adviser of the FAO/UNDP Sepik River Fish Stock Enhancement Project, Papua New Guinea, was elected Chairman of the General Session of the Working Party.

The agenda and list of participants are appended in Annexes A and B. The list of country status reports on inland fisheries is in Annex C, and the full versions are produced in the supplement to this report.

B. REVIEW AND DISCUSSION OF THE IMPLEMENTATION OF THE PROGRAMME SINCE THE FOURTH SESSION OF THE WORKING PARTY (Kathmandu, Nepal, 8-14 September 1988)

IMPLEMENTATION OF RECOMMENDATIONS

1. Coldwater fisheries resources

The Secretary reported on the progress made in coordinating the collation of information on coldwater fish stocks and fishery resources in Asia. To date, draft manuscripts have been received on the following zoogeographical areas: Indian Himalayas (rivers, streams, lakes, reservoirs, culture of coldwater fish); Western Ghats (India); Nepal; Issyk-kul and Pamir area of the USSR - Central Asia; Altai and northern Tien-Shan of the USSR. The following areas are still to be covered: Mongolia, China (high mountain areas), Pakistan, Bhutan, and Afghanistan. The Secretariat, aware of the interest in coldwater fisheries of other tropical and subtropical areas of the world, has also given an author's contract for a study of Latin America, and is actively seeking an author to undertake a study of tropical Africa. While the studies of Asia and Latin America are expected to be completed by 1992, that of Africa may be delayed.

Discussion centred on various aspects of coldwater fish species in the Himalayan belt. Some reservation was expressed about the term 'coldwater fish and fisheries' as some areas concerned include mixed zones inhabited by both warm and coldwater species. It was recognized that while induced breeding is possible, there are still limitations towards achieving good growth rates. It was also mentioned that coldwater trout hatcheries have been

set up in a number of countries, and others are now under construction (e.g. Pakistan). It was stressed that in some countries (India,Pakistan, Bangladesh), *Tor* has been seriously depleted due to overfishing, pollution impacts, and regulation of rivers by large dams, and that this fish is considered as a threatened species in some areas. Competition between common carp and *Schizothorax* in some Kashmir waters has led to the almost complete disappearance of *Schizothorax* which can now be classified as an endangered fish species. It was also pointed out that modifications in catchments make the conservation of species difficult.

The Working Party thus concluded that rehabilitation and maintaining coldwater fisheries in the Region should be given priority attention and that interaction of various countries is desirable. It was suggested that a workshop be organized with the assistance of the Secretariat to thoroughly review the problems and achievements in this area. Moreover, the Secretariat was requested to look into the possibility of reviving the project ideas put forward by the FAO Coldwater Mission which visited India, Nepal, and Bhutan in 1987 and follow up on the Mission's recommendation to establish a Regional Coldwater Training Center in the Region, preferably in India.

2. Fish and fisheries in large, non-regulated rivers of the IPFC region.

Considerable information is available in the Central Inland Fisheries Research Institute (CIFRI) in Barrackpore on the River Ganga in India. The Indian Government places much importance on the improvement of water quality in this river and on the rehabilitation of its fish stocks. Serious issues still remain to be faced, however, including the need for conservation of genetic resources of the Ganga. In Bangladesh, regulatory structures on rivers and their branches have caused a decline in fish stocks, with many fish now unable to enter the floodplains for breeding. For example, the contribution of valuable fish species like the major carps, to total catches has gone down from 20-25 per cent in the past to only 3-5 per cent at present - a situation that has led Bangladesh to giving top priority to the conservation of its fishery resources.

In Indonesia, riverine fish stocks make a significant contribution to inland fish production. For example, in Kalimantan, riverine catches account for 56 per cent of the total production from inland waters and River Musi in Sumatra is considered heavily exploited. Other rivers, like the Kapuas and Mahakam in Kalimantan, are less exploited but nevertheless exposed to some negative impacts of environmental degradation. In some large rivers, certain fish species (e.g. *Scleropages* and *Notopterus*) have been endangered as a result of environmental changes in the watershed areas. In other cases, the installation of barriers like weirs across rivers has effectively blocked fish migration routes and threatened migratory species to extinction. In the Kapuas river, there has been a noticeable change from large-sized fish to smaller ones. In the light of these changes, the Government of Indonesia has been pursuing the principle of sustainability in its approach to development and has undertaken detailed studies of river fish stocks and fisheries, as for the Kapuas and Musi rivers. These studies were carried out in collaboration with the Fisheries Research and Development Project sponsored by USAID. Copies of these studies are available at the Central Research Institute for Fisheries Research, Jakarta.

The Working Party suggested that the Secretariat should consider a review of the following, largely non-regulated rivers for which the best existing information is probably available at present: Mekong, Ganga, Meghna, Musi, Kapuas, Mahakam, Sepik, Fly, and perhaps Brahmaputra.

3. Fish and fisheries potential of irrigation canals

The Technical Secretary noted that a review on the topic by T.A. Redding and A.B. Midlen was published by the FAO Fisheries Department as Technical Paper No. 317. Limited additional information has also been obtained through a questionnaire responded to by seven countries in the Region, information from which has been summarized in Annex D. Among the countries represented at the Meeting, the best situation for the use of irrigation canals for fish production seems to exist in Bangladesh although the priority given to flood protection effectively limits fish production in such canals. Constraints to the full utilization of the fisheries potential of irrigation canals include the following: (i) uncertainty of water flow through irrigation canals; (ii) higher priority given to irrigation demands over fish culture; and (iii) poor collaboration between engineers and fisheries management in the design and operation of the engineering structures. In Indonesia, irrigation canals can be used for fisheries activities with permission from the Provincial Irrigation Service provided existing regulations are complied with. As the irrigation canals are administered by an authority different from the fisheries department, there is a great need for dialogue and collaboration between the two agencies in order to make the canals mutually beneficial to both users.

4. Predictive fish yield models

The Technical Secretary informed the Working Party of the recent publication of FAO Fisheries Technical Report No. 319 (by J. Moreau and S.S. De Silva) on predictive fish yield models developed for Sri Lanka, the Philippines, and Thailand. It was mentioned that the publication is a good starting point towards the use of predictive fish yield modelling in the Region although its value may be limited by the lack of suitable statistical and other baseline data. It was suggested that the models be tested in other countries and the results of these tests be reported back to the authors to enable an evaluation of their usefulness and applicability.

5. Statistical data

A comparison of data contained in the 1988 FAO Fisheries Yearbook with those on aquaculture (FAO Fisheries Circular No. 815) has shown that much remains to be done to make a clear distinction between these two categories. After a lengthy discussion, the Working Party requested the Secretariat to discuss with the FAO Statistics Division the need for a clearer definition of aquaculture, especially with regard to culture-enhanced fisheries and to water bodies which are regularly stocked, efficiently fished, and restocked. Since fisheries practices vary from country to country and it would be difficult to design generalized aquaculture data collection forms, it was suggested that the Working Parties on Aquaculture and on Inland Fisheries assist the FAO Statistics Division in this effort. In India, a central sector scheme has already been initiated to evolve a suitable methodology for

data collection on inland fisheries covering 16 states. The scheme has standardized and laid down concepts, definitions, and methods for collection of inland fisheries catch statistics.

A number of participants also commented on the poor statistical data collection in their respective countries, which makes it difficult for government planners and managers to use what is available for the detailed planning and programming of future fisheries development. It was suggested that the FAO Statistical Division should assist participating countries in developing a suitable system of collection or upgrading of existing systems of statistical data collection.

OTHER ACTIVITIES AND TOPICS

BIOLOGY

6. Fish genetic resources

In the Region, there is now a well-established Fish Genetic Resources Network financed by IDRC. Indonesia has completed the collection of 21 strains of common carp from its waters, which are now being evaluated for various parameters including growth rate and disease resistance, among others, with the purpose of conserving the purity of genetic strains. India held its last national conference on genetic resources in 1984. A conference of the regional network on genetic resources was held in Singapore on 10-17 November 1989 and an Asian Regional Workshop on tilapia genetics was held in the Philippines 29-31 August 1990. A National Bureau of Fish Genetic Resources has been established in India in 1984 to classify, catalogue, and evaluate the fish genetic resources of the country and their conservation. In 1988, Thailand established a National Aquaculture Genetic Institute in collaboration with IDRC, which is responsible for genetic improvement of native and introduced aquatic organisms.

The Secretariat was requested to obtain sufficient copies of the proceedings of the latter workshop from ICLARM for distribution to the Working Party members.

7. Synopses of fish species

No progress was reported to the Secretariat during the intersessional period. To assist in the task of identifying those commercial fish species for which synopses are most urgently needed, the Secretariat will prepare a list of the available synopses with their dates of origin, and will communicate to the stet Working Party members the need to update or prepare new synopses. The existence of synopses already produced by other organizations needs to be considered.

8. Aquatic weeds, fish, and fisheries

A manuscript on the use of aquatic weeds in fisheries in China is being edited and should be published shortly by FAO as part of the series of circulars produced by its Fisheries Department. In contrast, progress on the regional review has been slow as the

Technical Secretary has not been successful in his attempts to get a specialist willing to assist in the production of such a document.

The problem of aquatic weeds in open waters was discussed and cases of the rapid spread of water hyacinth in lakes and reservoirs were mentioned. Indonesia is faced with an acute problem of water hyacinth infestation in five reservoirs of the Brantas river in East Java, and has requested for assistance, especially since manual control, which is used at present, is expensive. The control of this weed using grass carp was suggested but may not be efficient. In Laguna de Bay in the Philippines, the water hyacinth problem was observed to have been more serious after the construction of the Napindan Hydraulic Control Structure that has effectively prevented saline water from Manila Bay from entering the lake and controlling the spread of the weed. In Bangladesh, the eradication of water hyacinth is in progress with the assistance of the World Food Programme.

The Secretary also said that the FAO Inland Water Resources and Aquaculture Service (FIRI) has participated in several projects dealing with the control of aquatic weeds where it represents the fisheries interests. Assistance in such projects has been recently requested by Bolivia, Niger, and Uganda; it is likewise assisting in the preparation of a regional aquatic weed control programme for West Africa. The Secretary reported that he expects to receive advice shortly on the best available biological control agents for water hyacinth and will disseminate this information to the members of the Working Party when it becomes available.

9. The role of birds as fish predators

In Sri Lanka, it is estimated that birds catch twice as many fish from inland waters as the fishermen. The other Working Party participants expressed interest in this subject and requested the Secretariat for information on it. The Technical Secretary drew their attention to the publication on the subject prepared by EIFAC in its series of occasional papers. The Secretary will mail this publication to the members for information, and the topic shall be discussed again at the next session of the Working Party.

FISHERY RESOURCES, POLICY AND PLANNING

10. Fish stocks and fisheries in catchment rivers situated above major lowland floodplains

Attention of the Working Party was drawn to Recommendation 2 of the Fourth Session of the Working Party requesting collaboration of the member governments in giving special consideration to the significance of rivers situated above major lowland floodplains for fisheries. The Working Party concluded that to make some progress in this field of concern, Dr. D. Coates of Papua New Guinea initiates collection of the required information, which could initially focus on such rivers in tropical countries. It was noted that much of this information may be available outside the IPFC region.

11. Hilsa fisheries

The importance of the hilsa fisheries to some countries in the Region was discussed and the information updated with reference to that reported at the Fourth Session (see 1988, FAO

Fish. Rep. (405), p.10, point 3.2). In India, a high priority is given to the rehabilitation of the hilsa fisheries. One hilsa hatchery is under construction and will be operational soon at the Farakka dam and another is planned for the Narmada river. Fingerlings are being released into the Ganga river above the Farakka dam.

It was also mentioned that fishways and fish ladders constructed in India and in Pakistan do not assist in hilsa migration although in India, some hilsa manage to move upstream during the floods, bypassing the Farakka dam. In Pakistan where hilsa formerly migrated 1 000 km upstream of the Indus, fishermen formerly engaged in the hilsa fishery, are now engaged in reservoir fisheries. In Bangladesh, the Government is concerned about a decline in the inland water stocks of hilsa which, at present, contribute about 13% to inland fish production, 42% to riverine production, and 50% to the marine fish catches. In total, about 180 000 mt/year of hilsa are harvested by some 600 000 fishermen employed in this fishery.

It was suggested that studies be conducted on the biology and behaviour of different hilsa stocks in as much as each stock may require a different fisheries management approach. More work also needs to be done to solve the problem of how to get the migratory hilsa stocks across dams, both upstream and downstream. Suitable structures to assist hilsa safe passage over dams need to be designed and it was suggested that FAO assist in this task.

Dr. Jhingran proposed the establishment of a joint India - Bangladesh programme on hilsa to investigate some urgent technical matters as well as look into the possibility of joint management of these valuable stocks. The Secretariat offered to find out what the Bay of Bengal Programme (BOBP) is doing in the field of hilsa fisheries and make a report on its findings to the Working Party members from India, Pakistan, and Bangladesh.

12. Fish and fisheries in small water bodies of the Indo-Pacific Countries

Thousands of small water bodies (village ponds, small irrigation reservoirs, roadside ditches, etc.) are available in the Region which could be tapped for fish production to meet the animal protein requirement of the different countries. Bangladesh has about 1.3 million of such water bodies and there are many in China, India, Pakistan and other countries of the Region. In Sri Lanka, only about one per cent of the estimated 50 000 small water bodies is now used for fish production. It is believed that utilizing all of them could easily result in a doubling of present fish yields.

Some of these water bodies are completely dry during certain times of the year; others may be subject to overflowing during the flood season, resulting in fish escape. Some have relatively high salinity. Some of them are already managed by regular fish stocking and by the introduction of cage culture. Others have served for experimental purposes such as in studies of population parameters. India has a programme of bringing more of these small water bodies under fish culture and converting them into self-contained systems. China has introduced an efficient system of fisheries management on some linear systems of small water bodies. In Punjab, in Pakistan, where about 10 000 of such small impoundments are found, the Fisheries Department has initiated a fish stocking programme in these water bodies.

The Working Party recognized that these small water bodies may be more efficient for fish production than large reservoirs although this would depend on regular stocking which may constrain its further development in some countries. The Working Party **recommended** that during the forthcoming intersessional period, the IPFC member countries assemble baseline information on the number of small water bodies, their types, their present uses for fish culture, and their potential for future development, and present the results of their findings at the Sixth Session of the Working Party.

13. Fish stocks and fisheries potential of saline inland waters

It was mentioned that in some countries of Asia and Australia, saline waters represent substantial fisheries potential. For example, Lake Qinghai in China has an important naked carp (*Gymnocypris przewalskii*)fishery which provides fish to the remote, landlocked Qinghai province. Northeastern Thailand has a large number of saline water bodies with high potential for culture of *Penaeus monodon* and Artemia. However, such culture has not yet been implemented as a result of the lack of appropriate legislation to control saline water intrusion into nearby freshwaters. Pakistan, Punjab, Sind, and Northwest Frontier Province (NWFP) have large numbers of saline water bodies, and need advice on their rational use for fish production and aquaculture. In India, some saline water bodies have been already used on a small scale for fish production.

The Working Party **recommended** that this topic be placed again on the agenda of the next Working Party session and that members of the Working Party prepare consolidated information for discussion. During the intersessional period, the Secretariat will approach the members for additional information.

14. Fisheries policy and planning

Two activities in this area were reported by the Secretariat: (i) the publication of FAO Circular No. 826 on the Development of Inland Fisheries under Constraints from other Uses of Land and Water Resources: Guidelines for Planners; and (ii) the collation by the FAO Legal Office of all existing rules and regulations on inland fisheries in the countries of the Asia region, which is expected to be published during the next intersessional period. It was mentioned that the countries from which materials are presently available include: Bangladesh, China, Fiji, India, Iran, Iraq, Malaysia, Myanmar, Pakistan, the Philippines, and Syria. The countries from which materials are still needed include: Australia, Bhutan, Japan, Kampuchea, Democratic Republic of Korea, Indonesia, Laos, Maldives, Mongolia, Nepal, New Zealand, Papua New Guinea, Singapore, Sri Lanka, Thailand, and Vietnam. The Working Party members then reported that national workshops on fisheries policy and planning have been held in their respective countries in the recent past although the emphasis on inland fisheries varied from one country to another. In most cases, however, inland capture fisheries was of a lower priority than marine fisheries and aquaculture.

In the Philippines, the 1987 National Conference on Fisheries Policy and Planning co-sponsored by FAO/UNDP and participated in by a broad range of participants from all concerned sectors, served as a consultative forum to generate information used to formulate the Fisheries Sector Programme now being implemented by the Department of Agriculture under a loan from the ADB. That Conference dealt with issues involving all subsectors of

the fisheries including inland fisheries. The Fisheries Sector Programme that came out of it, however, has given more importance to coastal resource management, including brackishwater aquaculture and marine culture, in view of the more urgent and pressing problems in that area.

In Bangladesh, policies proposed at the National Workshop held in 1989 will need to be implemented. In Sri Lanka, the workshop held in 1989 included the technical aspects of inland fisheries in the Mahaweli River Basin. In Pakistan, the workshop organized jointly by the Government of Pakistan and FAO in 1988, was dominated by aspects devoted to marine fisheries.

In Indonesia, a national workshop held with the participation of FAO included considerable discussions on fisheries policy and planning for freshwaters, including research, fisheries resources, and aquaculture, addressing itself to the forthcoming long-term plan for the next 25 years. In connection with the Workshop, two fora were also held: one on the status of the current fisheries situation; the second, on research strategies in fisheries. A third forum, planned for 1992, will deal with general policy strategies for planning.

It was noted that FAO, through its Division of Policy and Planning, has been contributing to, and assisting in, the organization and conduct of such policy and planning workshops, an assistance that is greatly appreciated by the countries. It is expected that FAO will continue to provide this assistance, particularly in the area of inland fisheries and aquaculture which have the best potential for sustainable development.

15. Regional Symposium on Sustainable Development of Inland Capture and Culture-enhanced Fisheries

The Secretary informed the Working Party that this symposium has been scheduled for 1993. The need for such a symposium has arisen from the fast deteriorating situation in a number of lake and river basins in the Region. For example, in Lakes Tempe, Tonle Sap, and Laguna de Bay, the environmental degradation in the catchment areas has led to increased siltation which, in combination with other pressures on the fish stocks, has led to a decline of fishery resources. Similarly, increased rates of river and lake basin manipulation by multiple users and intensive fish farming causing increasing eutrophication in some lakes are important considerations that need attention. An urgent assessment of water bodies under stress is imperative if measures of assistance are to be formulated and implemented. The Working Party recognized that the socio-economic aspects of inland fisheries be considered for effective management. In this connection, it was suggested that the planned Symposium include in its agenda items such as fishing gear and fishing effort and collection of fisheries statistics. It was **recommended** by the Working Party that the Symposium deal with these issues as part of the agenda and that the Symposium be held in conjunction with the next session of the Working Party. During the Session the Working Group prepared a preliminary draft outline of the Symposium agenda.

OTHER ITEMS

16. Mangroves

It is only in the Philippines where a major undertaking involving mangroves, was reported. The mangrove reforestation project is being implemented by the Department of Environment and Natural Resources (DENR) in collaboration with the Department of Agriculture (DA) using funds from the Asian Development Bank (ADB).

17. The use of fish for improving water quality and mass removal of fish

The Secretary briefly described two approaches used in temperate countries, i.e. biomanipulation and mass removal of fish, to improve the water quality of lakes and reservoirs, which can be applied in tropical and subtropical countries. He said that the nutrients found in eutrophic waters and bioaccummulated through food chains could be removed through mass removal of fish. The use of tilapia to improve water quality in a Singaporean reservoir was given as an example for the application of this approach in the IPFC Region.

It was also mentioned that mass removal of fish could be applied to prevent stunting and to remove unwanted fish, although there are really few such species in the Region. The usefulness of methods for mass removal of fish therefore lies in their applicability for harvesting fish in undrainable water bodies, for selective harvesting or thinning of fish stocks to prevent stunting, fishing in selected habitats, for individual fish species or age classes and perhaps some other purposes.

In China, electrofishing using large electrified seine nets has been used to remove up to 80% of fish stocked in undrainable water bodies. In Pakistan, selective methods to remove small-sized *Puntius* in a shallow reservoir rich in submersed aquatic weeds, are required as trawling is deemed unsuitable since it would disturb the weeds and muddy the water. Sri Lanka experience is that the small cyprinids can be differentially exploited using small mesh (15-52 mm) gill nets without any detrimental effect on the existing fishery which is based on cichlids. These minor cyprinids could be used for purposes other than for human consumption, for example, for fish meal, if harvested in sufficient quantities. In Bangladesh, rotenone and the organophosphate phostoxin are used for fish removal.

In certain areas in Indonesia, tilapia is considered an unwanted species. In Lake Toba, Sumatera, for example, the fishermen have requested assistance in eradicating tilapia (*O. mossambicus*) which they blame for the disappearance of the more preferred local species and which has shown signs of stunting, as in the Karangkates and Selorejo reservoirs in Eastern Java where 90 per cent of the tilapia are stunted. Biological control of the fish with the use of predators has been suggested but is not acceptable as the predator could cause irreversible damage to other species in the water body and would be most difficult to eradicate after it serves its purpose.

In Thailand, some reservoirs have large populations of economically important fish which cannot be harvested by existing methods and which could possibly be removed by electrofishing, except that it is not allowed.

As there seems to be scope for applying approaches developed and used in temperate countries, the Working Party welcomed the suggestion that the Secretariat will distribute information available in this field, particularly from the two EIFAC-organized meetings in 1989 and 1991. The Secretary also offered to assist in linking the IPFC member countries with EIFAC member countries with the best experience in this field.

18. Codes of practice on introductions and transfers of freshwater organisms

Indonesia, which has recently established a Fish Quarantine Institute, translated the EIFAC Codes of Practice and uses them as major tools in fish quarantine training courses. The Codes have also been extensively applied in Papua New Guinea (PNG) for the FAO/UNDP project on the Sepik River Fish Stock Enhancement. It was noted, however, that in PNG, the quarantine section of the Code is the most difficult to implement especially because setting up of the revised quarantine facilities would entail a large expense. In India, it is expected that any candidate aquatic organism for introduction will be screened, but clandestine introductions cannot be fully prevented. Bangladesh has no quarantine system.

It was pointed out that there is considerable scope for fish quarantine at source for those countries where no quarantine facilities are available. It was also reported that the Asian Fisheries Society will soon undertake the development of a Code of Practice for introductions of exotic species for the Region.

19. Inland fisheries of Indo-Pacific countries and FAO Fishery country profiles

The Secretariat requested the members of the Working Party to revise the entries on their respective countries in FAO Fisheries Circular No. 794 so that an updated revision can be published in 1992. The Secretary also distributed copies of FAO fishery country profiles to the individual members for updating and transmittal back to the Secretary in Rome before the end of 1991.

20. List of inland fisheries and aquaculture specialists

The Secretariat is planning to update the list of inland fisheries specialists included in FAO Fisheries Circular No. 796 (April 1986), with the updated version to be published in 1992. During the past intersessional period, the following countries provided new or revised lists: Australia, China, New Zealand, Papua New Guinea, Turkey, and Vietnam. The members of the Working Party were requested to provide the Secretariat with updates or new lists by December 1991 to give enough time for the compilation and printing of the new information.

21. Proposal to establish an IPFC series of fisheries publications

The IPFC is the only FAO regional body which does not have its own series of fisheries publications. At present, fisheries publications relevant to, or produced for, the IPFC region are included in one of the FAO Fisheries Department publication series. If a

new series is established, some publications which are formatted as Fisheries Circulars at present, and therefore have a very limited distribution, could be placed in the series of Occasional Papers for the IPFC Region; other high quality technical papers could be placed in the series of IPFC Technical Papers.

It was suggested that the responsibility for the preparation of the documents for the IPFC series be as follows: marine fisheries - Regional Fisheries Officer; aquaculture - Regional Aquaculture Officer; inland fisheries - Fishery Resources Officer of the Inland Water Resources and Aquaculture Service, Fishery Resources and Environment Division, FAO, Rome. The Working Party **recommended** that this suggestion be presented to FAO Headquarters for further consideration and implementation in close collaboration with RAPA, Bangkok.

GENERAL DISCUSSION

22. Membership in the Working Party and attendance

The present members of the Working Party noted with concern that participating experts came from only nine countries in the Region, including one which is a non-member. The Secretary explained that two members of the Working Party were prevented from attending the Session by their respective governments at the last minute in spite of an agreement between the Governments and FAO that members of the Working Party are nominated in their personal capacity. Another observer failed to arrive for some other reason. Thus, only 8 out of 17 IPFC member countries had experts attending the present Session. In as much as the efficiency of the Working Party could be higher if all nominated members are present, and considering that it is difficult to get a 100% turnout at meetings, it was **recommended** that representations be made with the Commission to raise the present ceiling of 10 paid participants to 15 to make the Working Party more viable, efficient and effective. The Working Party expressed confidence that in view of the high priority accorded to inland fisheries and aquaculture by the ad hoc Committee on Structure, Functions and Responsibilities of the Indo-Pacific Fishery Commission (IPFC) at its December 1990 meeting in Bangkok, Thailand, the IPFC will recognize the merits of this proposal and make funds available for the participation of 15 members at its Sixth Session.

23. Date and place of the Sixth Session of the Working Party

The Working Party **recommended** that the Sixth session be held in conjunction with the planned Regional Symposium on sustainable development of inland capture and culture-enhanced fisheries. Possible venues for the meetings are Bangkok, Thailand and Manila, Philippines. The Working Party member from the Philippines offered to assist with inquiries into the possibility of holding the Sixth Session and the Regional Symposium in Manila sometime in 1993.

C. WORKSHOP ON TILAPIA IN CAPTURE AND CULTURE-ENHANCED FISHERIES IN THE IPFC COUNTRIES

Recognizing the need for a review of the status of the tilapia capture fisheries in the IPFC Region in view of their considerable importance in some countries, the Fourth Session of the Working Party, Kathmandu, Nepal, 1988 recommended that this topic be made the subject of a workshop to be held in conjunction with the Fifth Session and held during 27-29 June 1991. Dr. Arun Jhingran, Director of the Central Inland Capture Fisheries Research Institute, Barrackpore, West Bengal, India, was elected Chairman.

24. The 1990 FAO Yearbook of Fisheries Statistics (Catches and Landings) and the 1990 FAO Fisheries Circular No. 815 (Rev.2) on aquaculture production give production figures of 260 223 and 179 667 mt, respectively, for capture fisheries and aquaculture for countries of Asia and the Pacific in 1988, as shown below:

	Capture Fisheries (mt)	Aquaculture (mt)
O. mossambicus	40 849	28 054
O. niloticus	28 120	93 749
O. spilurus		28
Tilapias not identified	191 254	57 864
Total	260 223	179 667

25. When compared with cyprinid production in Asia (excluding China) of 371 386 mt and 221 759 mt for capture fisheries and aquaculture, respectively, it can be said that the tilapias have been performing quite well vis-a-vis the cyprinids in the Region. The inclusion of China would change the total picture, though, as cyprinid production in that country is in the order of 3.7 and 3.8 million tons from capture fisheries and aquaculture, respectively, as shown below. As China production is based on the regular stocking of hatchery produced fingerlings and their efficient harvesting, the same figures are included under aquaculture in both statistical yearbooks. The difference is due to the absence of the production of 117 000 mt for black carp, which is not included in the yearbook of capture fisheries.

	Cichlids	**Cyprinids**
	ASIA (with China)	
CF	306.329	4.112.186
A	181.985	4.080.259
	CHINA	
CF	39.000	3.740.800
A	39.000	3.858.500

ASIA (without China)

CF	267.329	371.386
A	142.985	221.759

Where CF = capture fisheries and A = aquaculture

26. **Australia** traditionally relies on marine fisheries resources, with freshwater production contributing less than 2% to the country's total. Also, as alternative sources of animal protein are readily available, there is a little demand for freshwater fish for food. Lacking any real demand for the fish as a food or other resources, the importation of tilapias into Australia has been banned. Their culture is either prohibited or discouraged in all states except Tasmania (Bluhdorn). Fisheries authorities have been trying to control populations of *Oreochromis mossambicus* that have become established in Queensland and Western Australia, although overseas experience shows that this is likely to be exceedingly difficult, if not impossible. There is a growing concern in Australia on the potential impacts of *O. mossambicus* on the indigenous species although no exact information is available. It was pointed out during the discussion that management decisions such as those taken in Australia rest on a number of information inputs and that biological evidence should be weighed along with management needs, economic benefits, and political considerations. Based on the impacts of earlier introductions of terrestrial and aquatic organisms in the country, prudence dictates that tilapia not be encouraged in Australia.

27. *O. mossambicus* and *O. niloticus* were introduced into **Bangladesh** from Thailand in 1954 and 1974, respectively (Rahman). Unlike the other countries in the region, though, tilapia landings in Bangladesh have been rather insignificant compared to the total fish production, and came mainly from catches in Kaptai reservoir, from small seasonal ditches, sewage-fed ponds and lakes and from brackishwater creeks and canals. Tilapia is also harvested from freshwater ponds as well as from brackishwater shrimp ponds where they are accidental entries.

While good statistical data are lacking, yields from tilapia capture fisheries in Kaptai reservoir have been estimated at 2 890 mt in 1989-90. The small seasonal ditches gave yields of 1 000-1 800 kg/ha in 3-5 months and 11 sewage-fed ponds near Dhaka were reported to have produced 5 mt/ha/yr. DOF estimates that a total of 1 643 mt of tilapia was produced from approximately 147 000 ha of freshwater ponds in the country and another 1 069 mt from some 100 000 ha of coastal shrimp farms.

Tilapia is considered a potentially good species for culture in view of its ease of rearing, low cost of production and good profit margins. However, the consumers are not as yet accustomed to its taste and much still remains to be done before the fish is widely accepted in the country.

28. In **India**, there is no other species of fish that has generated so much controversy as tilapia (Jhingran). In the early stages of the country's inland fisheries development, it was considered prudent to introduce exotic species like *O. mossambicus* which adapted well, bred profusely, subsisted on a variety of food under diverse ecological situations, and contributed substantially to national fish production. Since then, however, the long-term performance

of the fish in some of India's waters as well as its biological plasticity have posed a series of questions on its desirability in waters which harbour a rich and highly diverse native ichthyofauna. While its capability to make a sizeable contribution to total fish yield remains unquestionable, the argument for and against the species centres more around its impact on the co-existing endemic fauna. In the absence of in-depth biological investigations on the species in the Indian context, doubts raised about the species still remain unanswered.

Nevertheless, tilapias have been stocked in a number of South Indian reservoirs with varying results and in brackishwater impoundments of West Bengal. For example, tilapia production in Tamil Nadu reservoirs is higher in smaller reservoirs (< 50 ha) at about 101.5 kg/ha as compared to that in large reservoirs (> 10.000 ha) which gave yields of only 0.14 kg/ha. The average tilapia yield in 45 reservoirs was a low 7.8 kg/ha.

It was noted that tilapia is utilized in reservoirs with high densities of blue-green algae which the fish is able to digest. It was also mentioned that *O. niloticus* has a better market acceptance than *O. mossambicus*.

It has been observed that the initial surge in tilapia numbers was often followed by a drop almost simultaneous to an increase in carp populations. It was suggested during the discussion that there is a need to develop productivity models relating to reservoir size, carp numbers, tilapia numbers, and other parameters.

29. In **Indonesia**, tilapia fisheries produced 57 245 mt in 1988, representing 8% of inland fisheries production (Hardjamulia). Of this volume, 7 980 mt were caught from open waters while 49 265 mt were produced in both fresh- and brackishwater culture activities. Tilapia are caught in rivers in Java, but not in Kalimantan or Sumatra, and harvested from milkfish and shrimp ponds where they constitute an "extra crop". Intensive tilapia culture in floating cages in reservoirs has also been recently started.

As in India, *O. niloticus* is preferred to *O. mossambicus* and is a cheap source of animal protein for the lower-income groups, especially those far from the sea.

Where there is competition over the water resources, intensive culture of *O. niloticus* and red tilapia may be required in Indonesia, and is likely to take the form of floating cage culture as has already been applied in some reservoirs. In the future, it is planned to stock tilapia only in closed systems, i.e. lakes and reservoirs.

30. In **Papua New Guinea (PNG)**, the tilapia fishery is based entirely on *Oreochromis mossambicus* which was brought into the country in the late 1950s (Coates). It is in the Sepik/Ramu River basin in the northern part of the country where the species has become important in the capture fishery, yielding 3-5 mt/year and contributing about half of the artisanal/subsistence catch in the area. At present, *O. mossambicus* is the only freshwater fish species which forms the basis of the inland commercial fishery and is the most important fish species in PNG, including marine species (except tuna which is largely taken out of the country by foreign fishing fleets).

The success of *O. mossambicus* in PNG may be attributed to lack of predators that prey on it and to its detritivorous habit that enabled it to occupy a vacant ecological niche, there being no known detritivores among the native species. Moreover, it appears less susceptible to disease unlike the native species which have been shown to carry heavy parasitic loads. There are also no known cases of *O. mossambicus* causing the extinction of native species despite its dominance in fish catches for over 25 years now.

At present, the PNG tilapia fishery is not managed directly except for the stocking of the river basin with *Tilapia rendalli*, a macrophyte feeder selected for a number of reasons including the following:(i) ease of handling and breeding; (ii) ability to obtain stocks of known genetic origin; and (iii) ability to obtain stocks quarantined at source. Its performance vis-a-vis the common carp cannot be compared at the moment considering that the common carp has just recently entered the Sepik/Ramu system
and stocks have not stabilized as yet. There are indications, however, that common carp may contribute significantly to the fishery in the future.

31. Sri Lanka is another country in the Region where the inland fish production is mainly based on the exotic tilapias *O. mossambicus* and *O. niloticus* (Amarasinghe and De Silva). Prior to their introduction into Sri Lanka reservoirs, fish production was very low, which was believed to be due to the lack of lacustrine or lacustrine-adapted species among the indigenous fish fauna. Their successful establishment in reservoirs, as manifested by significant contributions ranging from 56 to 99 per cent of total landings, has been attributed to the highly favourable environments in the reservoirs and to their ability to utilize the blue-green algae abundant in the water.

In contrast, the contribution of exotic carps to the reservoir fishery in Sri Lanka has been insignificant, probably on account of a number of reasons. First, all the introduced carps are sub-tropical and none of them, except for *Cyprinus carpio*, has established breeding populations in the reservoirs. Secondly, stocking-recapture fisheries successfully practised in some countries like China, has not been scientifically planned in Sri Lanka and has therefore not given good results. Thirdly, there is an inadequate supply of carp fingerlings of the right size for stocking in the reservoirs; thus, stocking densities used are low. With high mortalities due to predation by carnivorous fish species and piscivorous birds, fish yields can not but be low. Even in situations where stocking densities are appreciably higher, as in medium-sized reservoirs of less than 1 000 ha in area, the benefits of stocking-recapture fishing have to be carefully evaluated against alternative methods for increasing fish yields in inland waters, such as development of culture-based fisheries in seasonal tanks.

The inland culture fishery, be it cichlid- or cyprinid-based, is not well developed in Sri Lanka. Where practised, tilapia yields from ponds range from 200 to 500 kg/ha. Carp is grown in polyculture in ponds but no figures are available as to its economic feasibility. There is evidence to suggest that there are apparent synergistic effects of tilapias and cyprinids, with the presence of tilapias possibly important for increasing overall yields.

No detrimental effects of introduced cichlids have been reported in Sri Lanka and with their high consumer preference, they are likely to remain the most important fish group in the country's inland fisheries development.

32. In the **Philippines**, tilapia is the most extensively used finfish in inland waters where it is either stocked in open waters or cultured in cages and ponds (Baluyut). *O. niloticus* is the most preferred species for stocking and culture although other species are available locally (e.g., *O. mossambicus, O. aureus, T. zillii*) and hybridization trials are continuing to develop new and better strains such as red tilapia hybrids. In 1989, a total of about 102 000 mt of tilapia was produced in the country, of which about 20 000 mt were caught from the wild and about 82 000 mt were harvested from aquaculture. Tilapia freshwater capture production represents about nine per cent of the country's total production of about 200 000 mt from inland fish capture; it contributed about 13 per cent to the total aquaculture production of about 630 000 mt. Most of the tilapia production from aquaculture comes from the fish cages in Region IV, where Laguna de Bay and other smaller lakes are located.

Tilapia cage culture in the Philippines, started in 1967, expanded rapidly and reached its peak of 1 000 ha in Laguna de Bay in 1983. Since then, it has somehow declined in importance, with the areal coverage in Laguna Lake estimated to be just about 260 ha at present.

33. In **Thailand**, tilapia has been contributing quite significantly to inland fish production since 1983, with yields ranging from 2 500 mt in 1983 to 13 600 mt in 1984 (Pawaputanon). Annual average production for the period 1983-1988 was 6 730 mt, lower than that for *Puntius* (10 530 mt) and *Channa* (13 650 mt), the two most common fish in Thai reservoirs.

O. niloticus is the most common species harvested from village ponds in the country, accounting for 20.68 per cent of total catch from such ponds in 1986. Large reservoirs whose surface areas exceed 1 000 ha are believed to have high potential for tilapia production as considerable quantities have been observed from the catch landings, although accurate statistics are not available. This potential lies in its ability of the fish to establish populations within a reservoir on account of its natural reproductive ability, thus eliminating the need for regular stocking of fingerlings.

34. Quantified historical data on tilapia introductions and stocking in the inland waters of **Malaysia** are poor (Yap). FAO Fishery Statistics Yearbook for 1988 gives a yield of 3 346 t, of which *O. mossambicus* represented 2 350 t. Thus, tilapias contributed about 20 per cent to the total inland fisheries catch whereas the cyprinids contributed perhaps 60 per cent of the total catch of 16 252 t in 1988. In cage culture, *O. niloticus* accounted for 73.4 per cent of the total cage production while red tilapia accounted for 8.2 per cent. At present large numbers of nile tilapia and red tilapia are stocked into reservoirs and rivers. In 1988, 27.4 per cent of nile tilapia and 14.2 per cent of red tilapia seed produced in government hatcheries in Peninsular Malaysia were released into public water bodies. *O. mossambicus* is stocked in recreational water bodies for sport fishery and into sewage oxidation ponds where it serves as biological filter.

35. A regional analysis of the tilapia fishery, prepared for the countries of **Latin America** by Juares-Palacios, was presented for comparison with the experience available in the IPFC Region. In a number of countries in Latin America, tilapia is either in the early stages of being established or has not yet become established in open waters such as reservoirs and

lakes. Three countries in Latin America (viz., Cuba, Brazil, and Mexico) are well-advanced in their management of reservoir fisheries in which tilapias figure prominently.

Cuba started stocking its reservoirs with tilapia in the late 1970s. *O. aureus* is now the most important species in the catches (with 14.9 mt landed in 1988) followed by *T.rendalli*, common carp and black bass (*Micropterus salmoides*). The systematic seeding of reservoirs and the increased efficiency of fishing techniques and fisheries management have led to a sustainable growth in inland fisheries, which is based largely on tilapias. The largest reservoir, Zaza (11 400 ha) had an average fish yield of 95.5 kg/ha/yr for the 1984-1988 period; 15 other Cuban reservoirs had average fish yields ranging from 11.5 to 297.2 kg/ha/yr. Capture limits are established on the basis of the following: morphoedaphic index; historical capture series and efforts analysis; relation between capture per unit area and phytoplankton density; and prediction model application.

The highest number of small reservoirs (dams) (about 60 000) in Latin America is found in **Brazil**, specifically in the northeast where an average production of about 17 088 mt was recorded from 1979-1989 representing 8.1 per cent of the total freshwater fisheries of Brazil. *O.niloticus*, a favoured exotic introduced into the country in 1971, dominates the catches. From 1980 to 1988, it has consistently topped the list of species landed, followed by the local *Plagioscion squamosissimus* and *Cichla ocellaris*. The exotic tilapias contributed from 75.2 to 81.1 per cent of the total landings in the same period. Stocking material is produced in seven fisheries stations in the Region.

Among the measures recommended for increasing fish production is the eradication of the carnivorous species *Serrasalmus rhombeus* (piranha) and *S. natereri* (pirambeba) using chemical methods.

In **Mexico**, reservoirs have been stocked with tilapia and common carp. Tilapias are widely accepted in the rural areas and among lower-income urban and suburban populations.

In the period 1979-1989, fisheries production from inland waters grew by 475 per cent, largely as a result of fish introductions and stocking. Statistics available for fisheries production from major dams show a sustainable rapid increase from 43 507 mt in 1982 to 123 000 mt in 1989. Four exotic fish species (i.e. *O. aureus*, *O. niloticus*, *O. mossambicus* and *Cyprinus carpio*) dominate the catches. In 1989, production for each species was as follows: tilapias, 76 575 mt; common carp, 25 881 mt; and *Chirostoma* spp (native fish species), 5 707 mt. In nine reservoirs, the fishery yield ranged from 8.1 to 815 kg/ha/yr.

Using predictive yield models, it is believed that the fishery potential of large dams is now largely fully utilized, while there is further possibility for expansion of fisheries in smaller reservoirs. In those reservoirs with substantial changes in water level and higher salinities, fish production potential is expectedly low.

WORKSHOP SUMMARY

36. In most tropical and subtropical countries of the Region, tilapias contribute in varying degrees to fish production. They are dominant or prominent both in inland capture as well as culture-enhanced fisheries in Sri Lanka, Papua New Guinea, Philippines, Indonesia and some parts of India.

37. *O. mossambicus* is the first tilapia species introduced into most countries of the region and has formed the basis for capture fishery in some countries. It was only after the superior quality of *O. niloticus* was tested under aquaculture conditions that it was introduced into culture-based fisheries and, in the case of Thailand, also stocked in reservoirs. Both *O. mossambicus* and *O. niloticus* are doing well in reservoirs of medium or high productivity. More recently there has been a trend towards replacing *O. mossambicus* with *O. niloticus* in some water bodies of the Region. Such management is based on the knowledge that *O. niloticus* has a faster growth rate, does not develop stunted populations as readily as *O. mossambicus*, and is considered to have a better-quality flesh.

38. Experimentation with crossbreeding of *O. mossambicus* and *O. niloticus* has shown that hybrids are faster growing. Where both species are present in the same water body, such crossbreeding occurs naturally. In the Philippines, there is hardly any pure strain of *O. mossambicus* present in natural water bodies, although *O. mossambicus* was the first tilapia species to be introduced into that country.

39. Some problems of declining yield of tilapia in capture fisheries exist usually as the result of overexploitation, unsuitable habitats, and perhaps hybrid introgression. Uncontrolled developments in the catchments of some water bodies have also resulted in decreases in yields. Fishery management techniques could overcome many of these problems and should address the increasing and varying demands on the aquatic resource itself.

40. The uncontrolled expansion of cage and pen culture in some water bodies has led to the deterioration of water quality and has made both the open water fish stocks and those held in cages and pens vulnerable to fish diseases. In extreme situations, this could lead to a drastic, sometimes catastrophic, downturn in fish production. The Working Party recognized the need for a detailed analysis of such situation and for guidelines and criteria for maintaining sustainable and well-balanced development of cage and pen aquaculture and capture fisheries for the same water bodies. The forthcoming symposium on the sustainable development of inland capture and culture-enhanced fisheries in the IPFC region, programmed for 1993, is expected to discuss this subject in more detail.

41. The improvement of fish yields and fish quality through the introduction of *O. niloticus* in some water bodies with established populations of *O. mossambicus*, was discussed. The Working Party noted that *O. mossambicus* is performing well in some open water bodies in the Region (e.g., Sri Lanka reservoirs, Sepik River in PNG). It also noted that data on the superior performance of *O. niloticus* relates mainly to culture situations and may not be directly applicable to capture fisheries.

42. It was concluded that tilapias constitute an important protein source in many countries in the Region where they have found growing acceptance not only among the low-income groups but also among the more sophisticated urban and upscale markets. While their introduction into a number of water bodies has been justified, the Working Party strongly felt that further studies need to be undertaken to determine the impacts of tilapia introductions on the native species in lakes and reservoirs in the Region. The Working Party also expressed concern about the genetic purity of tilapia strains for future introductions and stocking. It was suggested that the Secretariat explore the possibility of collaboration with ICLARM in this area.

RECOMMENDATIONS AND PROPOSALS FOR ACTIVITIES DURING THE INTERSESSIONAL PERIOD

Recommendations

1. The IPFC member countries to assemble baseline information on the number of small water bodies, their types, their present uses for fish culture, and their potential for future development. The results to be presented at the Sixth Session of the Working Party (member countries, secretariat).

2. The IPFC member countries to prepare consolidated information on fish stocks and fisheries potential of saline inland waters. The results to be presented and discussed at the Sixth Session of the Working Party (member countries, secretariat).

3. IPFC series of fisheries publications to be established (IPFC).

4. The present ceiling of 10 paid members to the Working Party to be raised to 15 to make the Working Party more viable, efficient and effective (IPFC).

5. The Sixth Session of the IPFC Working Party on Inland Fisheries to be held in conjunction with the Symposium on Sustainable Development of Inland Capture and Culture-enhanced Fisheries, scheduled for 1993.

Other Activities

6. Editing of manuscripts on coldwater fisheries in low latitude countries (secretariat).

7. Fish and fisheries in large, non-regulated rivers of the Indo-Pacific: individual contributions to be drafted for an FAO publication on selected rivers (member countries, secretariat).

8. Preparation and distribution to member countries of a list of the existing synopses on freshwater fish (secretariat).

9. Initiation of information collection on fish stocks and fisheries in catchment rivers situated above major lowland floodplains (D. Coates, Papua New Guinea).

10. Assessment of methodologies for mass removal of freshwater fish in countries outside the IPFC Region for their suitability in countries of Asia and the Pacific. The Secretariat to assist in linking the IPFC member countries with EIFAC member countries with the best experience in this field.

11. Inland fisheries of the Indo-Pacific countries and FAO Fishery Profiles: up-dates to be sent to the Secretariat for collation and publishing (member countries, secretariat).

12. List of inland fisheries and aquaculture specialists: updates to be sent to the Secretariat for collation and publishing (member countries, secretariat).

13. Studies on impacts of tilapia introductions on the native fish species in lakes and reservoirs of the Region (member countries).

14. Further clarification of the definition of aquaculture, to enable the separation of the inland capture from inland aquaculture fisheries. Attention to be paid especially to culture-enhanced fisheries. Advising on developing a suitable system for upgrading of existing systems of statistical data collection (Fishery Information, Data and Statistics Service).

ANNEX A

AGENDA

THE FIFTH SESSION OF THE IPFC WORKING PARTY OF EXPERTS ON INLAND FISHERIES

24-29 June 1991, Bogor, Indonesia

24 June 1991

09.00-12.00:	Opening of the Fifth Session of the Working Party. Adoption of the Agenda Election of Chairman and Rapporteurs General Session of the Working Party
12.00-13.00:	Lunch
3.00-17.00:	Review and discussion of Intersessional Activities (Secretary of the Working Party and Participants)

25 June 1991

08.00-12.00:	Review and discussion of Intersessional Activities (continued)
12.00-13.00:	Lunch
13.00-17.00:	Review and discussion of Intersessional Activities. Programme for the next period.

26 June 1991

08.00-17.00	Excursion to floating cage culture fisheries at Cirata reservoir and to the Freshwater Aquaculture Development Centre in Sukabumi

27 June 1991

08.00-12.00:	Workshop on Tilapia in capture and culture-enhanced fisheries in the Indo-Pacific countries
12.00-13.00:	Lunch
13.00-15.00:	Workshop on Tilapia in capture and culture-enhanced fisheries (continued)
19.00-21.00:	Dinner hosted by the Director General of the Agency of Agricultural Research and Development (AARD)

28 June 1991

08.00-12.00:	Workshop on Tilapia in capture and culture-enhanced fisheries
12.00-13.00:	Lunch
13.00-15.00:	General discussion
15.00-17.00:	Drafting of the Session Report

29 June 1991

08.00-12.00:	General discussion and adoption of the report of the Working Party
12.00-13.00:	Closing of the Fifth Session of the Working Party

ANNEX B

LIST OF PARTICIPANTS OF THE FIFTH SESSION OF THE IPFC WORKING PARTY OF EXPERTS ON INLAND FISHERIES

24-29 June 1991, Bogor, Indonesia

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ANNEX C

LIST OF COUNTRY STATUS REPORTS ON INLAND FISHERIES[1]

(edited by Elvira A. Baluyut)

Development potential and constraints of inland fisheries management in India (Arun G. Jhingran)

Review of inland fisheries of Pakistan (William George)

Intersessional activities in inland fisheries in Papua New Guinea (David Coates and Walain K. Ulaiwi)

Recent trends in inland fishery of Sri Lanka (U.S. Amarasinghe)

Inland capture fisheries in Thailand (Oopatham Pawaputanon)

Inland capture fisheries in Malaysia (Yap Siaw Yang)

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[1] Full versions of these papers are produced as supplement volume to this report.

ANNEX D

THE USE OF IRRIGATION CANALS FOR FISH PRODUCTION IN SOME COUNTRIES OF ASIA, AUSTRALIA AND NEW ZEALAND

(Compiled by T. Petr, FAO, FIRI, Rome, Italy)

It is noted that irrigation canals are common especially in arid and semi-arid regions, but it is from humid tropical regions that most information on this aspect is known (Redding, T.A., Midlen, A.B.: Fish Production in Irrigation Canals. A Review. FAO Fisheries Technical Paper No. 317. Rome, FAO. 1990. 111 p). To obtain additional information the IPFC Working Party on Inland Fisheries therefore mailed a questionnaire (Appendix 1) to a number of countries with a request for information on the subject. The following countries responded:

Australia

Drain M in the Southeast Drainage Scheme, South Australia, which received surface runoff from agricultural land in the lower River Murray, and has permanent water, has a number of local fish species plus exotic ones. The commercially important species is yellow eye mullet *Aldrichetta forsteri*, and rainbow trout (stocked illegally). These fish, plus several other species, are fished recreationally.

The informant (Mr. B.E. Pierce, South Australian Department of Fisheries) concluded that potential for fish production in canals of South Australia is poor. Attempts are being made to use some limited areas to grow endangered fish for restocking into the wild. Yabbies (*Cherax destructor*, crayfish) have been tried in some canals, but bird predation decreased production and the crayfish burrowed into retaining banks causing water loss. As the trend is for water to be transferred in piped, covered waterways there is not much potential for the use of canals for fish production.

Iraq

We have been informed by the Ministry of Agriculture and Irrigation, Public Relations, that irrigation canals are not used for fish production.

New Zealand

Dr. R.M. McDowall of the Freshwater Fisheries Centre, Riccarton, Christchurch, informed us that in some canals there is a modest amount of natural rearing of brown trout, and that these find their way, sometimes, into river and lake systems where they are subject to some angling pressure. One or two larger canals attract anglers, but the significance of canals for fisheries is practically nil.

Turkey

We have been informed that irrigation canals in Turkey are not used for fish production.

Indonesia

Dr. Atmadja Hardjamulia from the Research Institute for Freshwater Fisheries, Bogor, mentioned that in West Java fish culture in cages, placed in irrigation canals or in streams, is a common practice. The cages are entirely or partially submerged.

Nepal

Due to the intermittent nature of water flow in irrigation canals in Nepal, the use of canals is considered to be at present uneconomical and no canals are being used for this purpose (Department of Agriculture, Fisheries Development Section)

Philippines

In wider and larger canals, net fish cages are in use for fish production. However, the fish production in canals is constrained by the intensive use of agricultural pesticides and herbicides (Bureau of Fisheries and Aquatic Resources).

QUESTIONNAIRE

The Use of Irrigation Canals for Fish Production

Name of canal:

Canal's origin:
(i.e. from a reservoir-surface water fed, or deepwater fed; uptake from a river; spring fed; other type (describe)

Duration and season of water flow in the canal (days, weeks, months):

Length of the section used for fisheries:

Width:

Depth:

Mean, range of current velocities or volume of flow (m^3/sec.):

Mean, and range of water temperatures:

Water quality:
(clear; silt loaded; polluted - specify: agrochemicals, pesticides, mine discharge waters, high salinity, other types)

Other relevant physico-chemical characteristics:
(e.g. conductivity, pH, alkalinity)

Aquatic plants in the canal: species and quantities (very abundant, abundant, rare)

Fish in the canal: naturally occurring species:

stocked species:

Fishing effort: kg/year (specify for what length of the canal)

Number of fishermen (per unit of length of canal):

If regularly stocked, purpose of stocking:
(e.g. fry/fingerlings production; table fish production; aquatic weed control; other - specify)

If stocked, briefly outline the process (species, type of stocking material (i.e. fry, fingerlings), densities stocked, area/volume of water stocked)

Production achieved by stocking, or by combination of stocking and wild population harvest (kg/ha, kg/length of canal):

Are there any special technical features in the canal to assist fish production (e.g. diversions, cages, bar gates etc.):

What are the constraints to fish production in the fish canal?

General question

What is the potential for fish production in canals of your country?

Any other comments you may wish to add:

ANNEX E

STRUCTURES FACILITATING MIGRATION OF FISH IN COUNTRIES OF ASIA, AUSTRALIA AND NEW ZEALAND

(Compiled by T. Petr, FAO, FIRI, Rome, Italy)

As proposed at the Fourth Session of the IPFC Working Party on Inland Fisheries, Kathmandu, Nepal, 8-14 September 1988, the Secretariat mailed a questionnaire (Appendix 1) to many countries of Asia and to the main island countries in the Indian Ocean and the Pacific. Responses were received from the nine following countries: Australia, China, Indonesia, Iraq, Myanmar, Nepal, New Zealand, Philippines, Turkey. Of these countries, no structures were reported for Indonesia, Myanmar, Nepal and Philippines. A summary of information follows.

Australia:

New South Wales:

The following information was provided by Mr. David Holleley, Technical Officer (Fish Passage), Fisheries Research Institute, NSW Agriculture and Fisheries Department, P.O. Box 21, Cronulla, NSW 2230.

New South Wales is divided into two main river drainages, the eastern and western flowing regions (Fig. 1). Historically, fishways in both these areas have been found to be largely unsuited to Australian conditions. Experiments on the swimming ability of native fish by Martin Mallen-Cooper, Fisheries Research Institute of the NSW Agriculture and Fisheries Department, have led to recommending vertical slot fishways, with dimensions and head losses shown in Figs. 2 and 3 for most barriers up to 4 m high. Barriers above this height have to be assessed individually. The Institute is also currently experimenting with systems to modify and improve existing ineffective fishways.

The following references refer to publications on the topic:

Harris, J.H.: Impoundment of coastal drainages of south-eastern Australia, and a review of its relevance to fish migrations. 1984, Aust. Zool. 21(3); 235-50.

Harris, J.H.: A survey of fishways in streams of coastal south-eastern Australia. 1984, Aust.Zool.21(3): 219-233

Mallen-Cooper, M.: Fish passage in the Murray-Darling Basin. (no reference)

Harris (1984a) identified 29 fishways on coastal streams of south-eastern Australia, between the Mary River in southern Queensland and Lakes Entrance in eastern Victoria. Only 9.3% of 293 dams and weirs and 23 causeways surveyed had provision for fish within river systems, either for survival or for maintenance of population abundance and distribution. He also stated that despite the need for fish passages, the behavioural responses and physiological limits of Australian fish that control their use of fishways are poorly known.

Five questionnaires were returned, with information on fishways on the Nepean River (four) and on the Murray (one). The fishways were constructed between 1988 and 1990. Field testing of these structures is in progress.

Victoria:

Only one fish passage device is operational in this state. The fishway is situated on the Cardinia Creek near Melbourne and guides fish around a 10 m weir. Only the galaxid *Galaxias maculatus* seems to use it. Mr. T.A. O'Brien, Aquatic Biologist, Department of Conservation, Forests and Lands of the Arthur Rylah Institute for Environmental Research, 123 Brown Street, Heidelberg 3084 who provided this information, pointed out that the migratory fish species have been restricted by various in-stream structures and more fish passing structures are needed. The Government of Victoria is now looking into this problem in a constructive way.

South Australia:

There is only one structure in the state, situated on the River Murray, Lock G. It was constructed in about 1926. The fish ladder is to assist the fish to overcome the 3 m lock. Its efficiency is questionable, however. The following fish species appear to use it on their way downstream: common carp, silver perch, *Bidyanus bidyanus*, Murray cod, *Macculochella peeli*, callop, *Macquaria ambigua*. It is not known whether any fish use it for their upstream migration; callop and silver perch migrate upriver on flood rising hydrograph. The need for more structures has been highlighted by Mr. B.E. Pierce, Senior Inland Fisheries Scientist, South Australian Department of Fisheries, Adelaide 5001, 135 Pirie Street, who mentioned that the fish passage had not been considered at all by water resource managers in South Australia until about 1985.

The Australian Society for Fish Biology recommended at its meeting on 2 March 1990 to hold a workshop on fish ladders in July 1991. A fish ladder working group has been formed for the Murray River. A data base of barriers to fish movement, fishways and their effectiveness is to be completed within two years.

China:

The following information was provided by Mr. Zhank Minkai, Freshwater Fisheries Research Centre and compiled by Mr. Xiangke Lu, Fishery Resources Officer, FAO, Rome, Italy. It covers the period prior to 1974.

By the end of 1973, a total of 22 fish passes (16 in the province of Jiangsu, others in Hunan and Hubei provinces) were constructed with water control sluice gates. The Doulong Sluice Gates of Doulonggang are situated in the lower reaches of the Yangtse River in the northern part of Jiangsu Province. Its main function is to control the discharge waters in the Lixia River that flow into the sea and to prevent tidal waters from entering lakes. The Doulonggang area is abundant in species that spawn in the coastal areas and enter fresh water such as eel, mitten crab *Eriocheir sinensis*) and two species of mullet, *Mugil cephalus* and *Liza so-iuy*. A fishpass was constructed alongside the Doulong Sluice Gates. This is a rectangle shape slanting fishpass that has 36 baffles. The width and length of this fishpass is 2 m and 50 m respectively. The designed deviation in water level is 1.5 m, depth of water in the fish pass is 1 m, maximum flow rate is 0.8 to 1.5 m/s. Under normal conditions, downstream and upstream flow both occur twice daily. During the downstream flow, species that migrate upstream are the eel, mullets, bass, black carp, grass carp, silver carp, bighead carp, common carp, crucian carp, Chinese bream and *Coilia mystus*. Mullets and bass represent the majority. From seven observations and counts with a total duration of 18 hours and 35 minutes taken from 1967 to 1968, a total of 41 952 eel, mullet, bass and common carp migrated upstream. On 27 April 1967, a total of 210 000 glass eel were observed to migrate upstream during a 2 hour period. During an upstream tidal flow on 1 July 1967, about 900 000 larvae of the mitten crab entered the river upstream. Other fishpasses that were constructed along the coasts of Jiangsu Province had similar results to the Doulong fishpass.

In 1973 a terrace type of fishpass was constructed at the Caohu Lake to enable grass carp, silver carp, bighead carp fry, glass eels, larvae of the mitten crab and *Coilia mystus* to enter the Caohu Lake.

The Wanfu sluice is constructed where the Huai River enters the Yangtse River in Jiangsu Province. This is the main sluice gate for fish to enter the Hongze, Gaobad and Shaobo lakes and the Huai River from the Yangtse River. The Jinghu fishpass was constructed for the Hongze Lake and the Gaobao fish pass was constructed for the Gaobao Lake. Fishpasses were also constructed at Wanfu, Taiping and the Sanhe sluice gates. The construction of these fish passes has generally contributed to the aquatic resources of more than 466 000 ha of lakes in the northern part of Jiangsu Province. Since the distance between the Wanfu and Taiping sluice gates is very small, these share one fishpass which is attached to the Wanfu sluice gate. The total length of this fishpass is 541.3 m with a bottom width 4 m and top width of 6 m. The waterflow in this fishpass is controlled at 0.5 to 0.8 m/s. Major species that pass through it are glass eel, larvae of the mitten crab and *Coilia mystus*. It was observed that normally one fish passes through every minute and about 70 to 80 fish per minute pass through during March and April.

Indonesia:

Dr. Atmadja Hardjamulia, Research Institute for Freshwater Fisheries, Jalan Sempur 1, Bogor, Indonesia, provided the following information: none of the dams constructed in Indonesia since 1958 have facilities assisting fish migration. One reason for this is the poor knowledge of migratory fish, the size of fish stocks, their importance for fisheries, and their migratory routes. The following migratory fish species of fisheries importance are now recognized: *Pangasius pangasius, Bagarius bagarius, Anguilla* spp., with the last one having

low economic importance. The poor attention paid so far to the problem is partly due to the fact that the responsibility for construction of the primarily hydropower production and irrigation reservoirs, is in the hands of the Ministry of Public Works. Fisheries demands have figured very little in the planning and decisions concerning dam constructions. However, such demands have not been voiced loudly enough by fisheries interests due to the poor knowledge of the biology of local riverine fish species.

Iraq:

The information was provided by the Ministry of Agriculture and Irrigation. Baghdad gives information on 14 structures to facilitate fish migrations. Of these seven are situated on the Euphrates and their tributaries, three on the Tigris, two on Shatt Al-Shamia, one on Kalatt salih, and one on Shatt Al-Kuffa. The structures facilitating fish migrations were constructed between 1939 and 1989. For all structures it is mentioned that they are used by the following three species of Barbus: *B. grypus*, *B. xanthopterous*, and *B. sharpeyi*, although the last species faces some difficulties as it is a slow swimmer. The fish undergo upstream migration for breeding purposes during the period March-mid-June. The structures are considered to be not very effective. It was pointed out that not all dams have structures to facilitate fish migration, giving examples of the Dokan and Darbanchi Khan dams. The large Saddam Dam would need a fish lift as it cannot accommodate a fishway.

Myanmar:

According to information supplied by the Fisheries Department of Myanmar, there are no structures assisting fish migration in this country.

Nepal:

No special structures assisting fish migration are present on the rivers and streams of Nepal. This information was provided by the Department of Irrigation and Fisheries Development Section, Harihar Bhawan, Pulchowk, Lalitpur.

New Zealand:

Henriques, P.R. (Aquatic biology and hydroelectric power development in New Zealand, Oxford University Press, Auckland, 1987, 280 pp) summarized in a chapter: **Fish passage control devices and spawning channels** (pp. 138-155) the experiences with these types of structures facilitating fish migration. This chapter is not a comprehensive review of all New Zealand fishpasses, screens and spawning channels as these facilities have also been constructed in conjunction with other works such as irrigation schemes. Fishpass regulations issued in 1947 gave fisheries authorities the right to require a fishpass on any dam or weir on rivers where trout or salmon do or could exist. The Freshwater Fisheries Regulations 1983, which superseded the 1947 Fishpass Regulations, give the Director-General of Agriculture and Fisheries the right to require fish facilities for any dam or diversion structure. The new regulations apply to native fish as well as acclimatised fish and can require the installation of fish screens as well as fishpasses. Provision of a fish passage is often expensive and fisheries authorities have been reluctant to require a fish passage unless there is a demonstrable biological requirement. Some fish, such as whitebait, eels and

salmon, migrate between the rivers and sea as an essential part of their life cycle. Other species, such as trout, may migrate to spawning areas. In some cases, financial assistance has been provided toward the maintenance of separate upstream and downstream fisheries without the provision of passage facilities between them. By 1987, only six fishpasses were constructed in conjunction with hydroelectric dams since 1947 (Table 1) and only four of these provide passage for trout or salmon. The author does not discuss fishpasses constructed for passage around obstacles other than power-stations.

A trap and haul system was initiated in the summer of 1983-4 to transport elvers from the base of the Matahina dam to above the Aniwhenua dam. A cheap eel pass to overcome a 5 m high steel structure on the Waikato River, was constructed using a brush filled pipe up which elvers climb from the outlet canal into Lake Waikare (Mitchel, C., Freshwater Catch, 1984 Spring:21-22). Lake Waikare provides an annual catch of 70 tonnes of eel. The same type of fishpass was constructed in 1985 on the Patea River, where upstream migration of juvenile eels (*Anguilla australis* and *A. dieffenbachii*) take place over summer. More passes are needed to facilitate the passage of elvers and climbing *Galaxias* and *Gobiomorphus* species in inland areas, and swimming passes for small native fish in lowland areas.

Philippines:

Information supplied by the Bureau of Fisheries and Aquatic Resources shows that the Philippines has not yet considered the need for structures facilitating fish migrations.

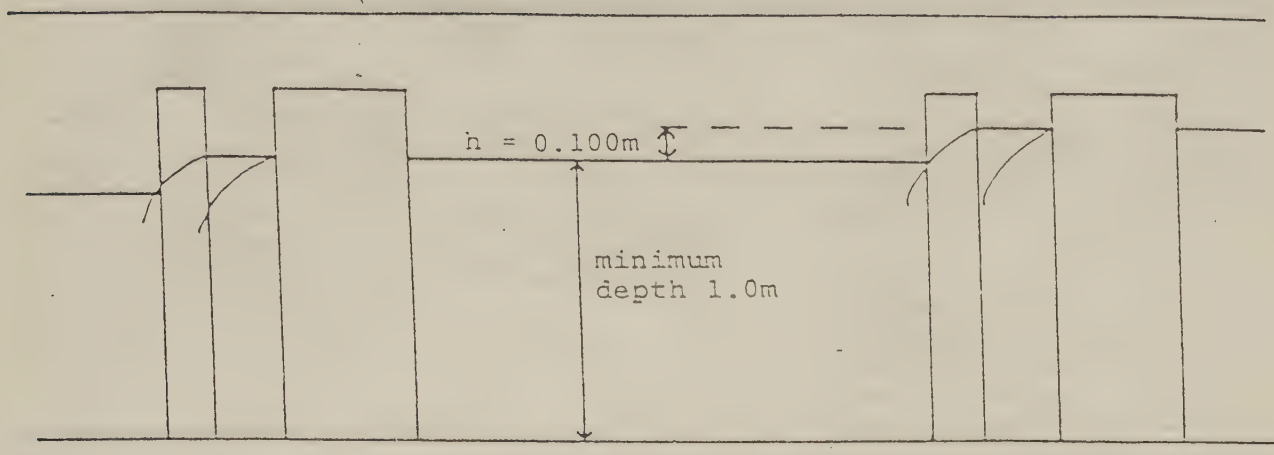
Turkey:

The General Directorate of State Hydraulic Works, Turkey, provided information on eight facilities. Five of them are to facilitate eel migrations upstream, i.e. Kum stream, Gediz River (2), Seyhan River, Goksu River, one to facilitate the migration of Anatolian trout (*Salmo trutta macrostigma*) (Esen stream), one for Black Sea trout (*Salmon trutta labrax*) (Bendimahi stream), and one for the rainbow trout (*Oncorhynchus mykiss*). All structures are of the same type, i.e. ladder and pond type with orifice, and the height given for five of them ranges from 1.7 to 5.8 m. For some fishways the minimum flow is given for its optimum functioning. For others comments are made on their utility. It is pointed out that fishways should be considered prior to the construction of dams and weirs.

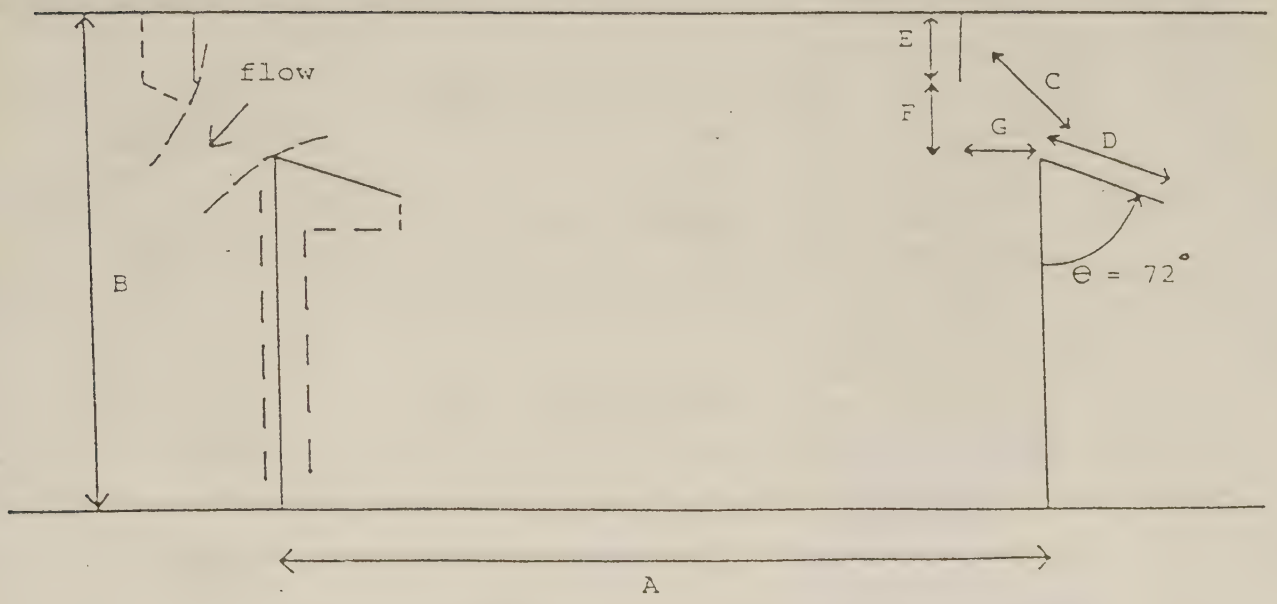
Figure 1

East flowing drainage includes parts of Queensland, New South Wales, Victoria and South Australia.

ELEVATION



PLAN



CELL RATIOS

A : B
1.0 : 0.6 or greater
(min. 'A' = 1.5m)

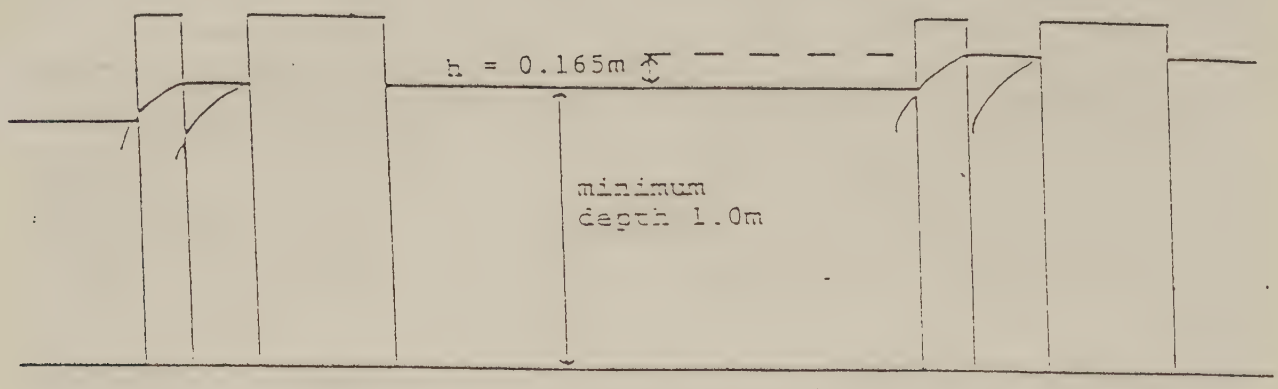
A : C
1.0 : 0.1 or less
(min. 'C' = 0.15m)

C : D : E : F : G
0.1 : 0.18 : 0.1 : 0.0707 : 0.0707

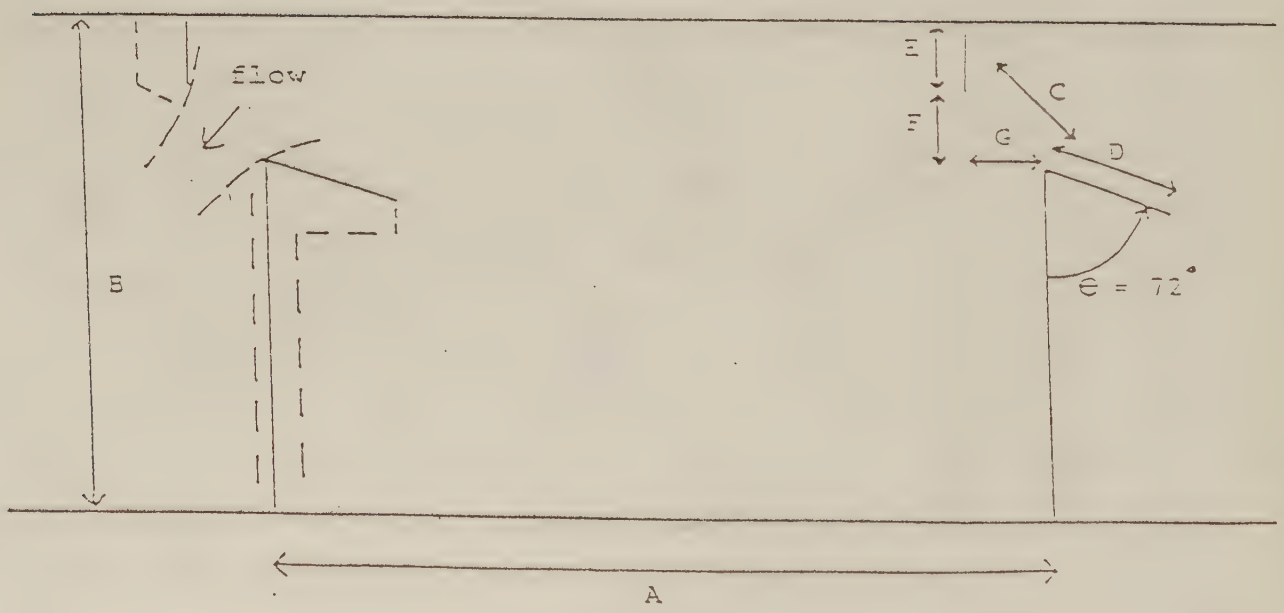
Figure 2

Design of vertical slot fishways for eastern drainage rivers in New South Wales

ELEVATION



PLAN



CELL RATIOS

A : B
1.0 : 0.6 or greater
(min. 'A' = 3.0 m)

A : C
1.0 : 0.1 or less
(min. 'C' = 0.30m)

C : D : E : F : G
0.1 : 0.18 : 0.1 : 0.0707 : 0.0707

Figure 3

Design of vertical slot fishways for western drainage rivers in New South Wales

Table 1
Hydroelectric Scheme
Fishpasses

River or Scheme	Construction Date	Fishpass type	Comments
Opuiaki (Tauranga)	1978	Pool and weir	1.4 m rise in steps of 0.3 m; large step at exit could prevent passage depending on flow conditions and weir plate adjustment.
Omanawa (Tauranga)	1978	Pool and weir	similar to above
Patea R (Patea PS)	1984	Eel pass	100 mm PVC pipe fitted with polypropylene brush allows elvers (young eels) to climb over the 64 m dam; simple, inexpensive with low water demand
Manganui R (Motukawa PS)	1930	Pool and weir	poor design which would never operate satisfactorily. 600 mm drop between rather small pools; flows vary with headwater level and are often inadequate; flow downstream of entrance often inadequate
Waiau R (Opunake PS)	1923	Pool and weir	6 m of vertical lift, recently refurbished, may operate for some native fish; small pool size
Branch R	1983	Weir and orifice	4 m of vertical lift; incorporates sediment sluicing facilities; small pool size creates excessive turbulence at design flow
Arnold R (Arnold PS)	1932	Weir and orifice	operated satisfactorily when first constructed but closed in 1938 to prevent upstream passage of eels
Waitaki R (Waitaki PS)	1934	Pool and weir	20 m vertical lift; too steep with inadequate entrance and attraction flows; demolished in 1951
Aviemore	1967	Pool and weir	3 m vertical lift; used successfully by rainbow and brown trout and sockeye salmon
Waiau R (Manapouri Lake control)	1976	Borda orifice	4.7 m vertical lift; operates reasonably but some problems with entrance and maintenance

QUESTIONNAIRE

Structures to facilitate fish migrations

Name of structure:

Type of structure:
(ladder, fishway, fishlift, fish transporting barge, fish trucking, structures preventing impingement and/or entrainment, other type - describe):

Place:
(name of the river, stream, dam)

Current year and cost of construction:
(when appropriate)

Annual maintenance cost:

Height:
(when appropriate)

Technical specifications:

Species of fish using the structure:

When (time period) and for what purpose (upstream, downstream migrations, breeding, etc.):

Effectiveness of the structure (give a critical account):

Are more structures needed to facilitate fish migrations in your country?
What type(s)? Why?

ANNEX F

LIST OF PAPERS CONTRIBUTED TO THE WORKSHOP ON TILAPIA IN CAPTURE AND CULTURE-ENHANCED FISHERIES IN INDO-PACIFIC COUNTRIES[1]

(edited by Elvira A. Baluyut)

Petr, T.: Tilapias in capture and culture-enhanced fisheries of the Indo-Pacific.

Bluhdorn, D.R. and A.H. Arthington: Tilapia in Australia and small Pacific islands: unwanted pest or unappreciated resources.

Rahman, A.K.A.: Country paper on tilapia: Bangladesh.

Jhingran, A.G.: Performance of tilapia in Indian waters and its possible impact on the native ichthyofauna.

Hardjamulia, A. and S.E. Wardoyo: The role of tilapia in capture fisheries and aquaculture in open waters in Indonesia.

Coates, D.: Review of tilapia in Papua New Guinea.

Baluyut, E.A.: Tilapia and the management of inland waters: the Philippine experience.

Amarasinghe, U.S. and S.S. De Silva: Cichlidae versus Cyprinidae: experience from the inland fishery of Sri Lanka.

Oopatham Pawaputanon: The current contribution of tilapia to capture fisheries in Thailand.

Yap, S.W.: The present status and the expansion potential of tilapia capture and culture-enhanced fisheries in Malaysia.

Ricardo Juarez-Palacios, J.: Tilapia in capture and culture-enhanced fisheries in Latin America.

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[1] Full versions are produced as supplement volume to this report.

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